Thoughts for 4-28-21 Tracer Test Kick-Off Meeting

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R Whitter Experience

- KFSA/WFSA Inactive Fuel Site Investigations
  - Tracer Test
    - Natural gradient
    - 3.5 day injection
    - Fluorescein
    - Issues with fluorometry and turbidity
    - Does appear the tracer was detected at the two target wells
    - Tracer moved out of injection at modeled rate for first 4-5 days
      - Then long trailing edge that persisted for at least two years
      - Model indicated tracer < DL in about 2 months

R. Whittier Experience

- Lahaina Groundwater Tracer Study
  - Forced gradient tracer test
    - 3 mgd wastewater injection well
  - Sampled at submarine springs
    - Prior with the N isotopic composition of algae had previsiously identified the intersection of the wastewater plume with the coastline
    - Sea surface temperature survey confirmed algal tissue analysis
  - 20 hr injection of Fluorescein
    - First arrival ~85 days; 50% mass discharge just shy of a year
    - Prolonged trailing edge ~ 5 yrs to< DL

R Whittier GW Flow Trajectory Investigative Philosophy

- Use the tracer test to:
  - Provide a metric against which to test the CF&T model
  - Physical test of groundwater flow trajectories up which to base remediation and release response decisions
- Exploit natural tracers to the maximum extent possible
  - KFSA/WFSA SO_4 depletion due to natural attenuation
  - Lahaina – $\delta^{15}N$, Sea Surface Temperature
- Red Hill
  - Chloride
  - Nitrate
    - $\delta^{15}N$

R Whittier GW Flow Trajectory Investigative Philosophy

- KISS
  - Keep it Simple Simon
- Background fluorescence sampling to assess natural interference
  - Have a 3-D fluorescence scan done some time ago on RH samples
- Assess flow at the potential injection sites
  - Borescope survey
  - Dye dilution test
    - Determine the rate at which natural flow will move dye from the borehole
- Use the maximum amount of dye mass practical
  - Transport analysis with current models can be used to evaluate dye concentration at the Red Hill Shaft pumps
  - Generate a large plume (this is a surrogate for a major fuel release)

R Whittier GW Flow Trajectory Investigative Philosophy

- Tracer test monitoring
  - Frequent sampling of near-field wells
  - Frequent sampling of injection well
  - Frequent sampling at the RHS pumps
  - It is likely quarterly sampling would be adequate for outlying wells.
- Downhole fluorometers might be an option to reduce sampling costs

D Thomas Experience/ Research Interests

- Groundwater geochemistry in Hawaii (dominantly on Hawaii Island) 45 years
- Detailed documentation of geology (wireline core drilling) and tying that to groundwater transport/storage
- Application of (isotope) geochemistry to understanding groundwater storage and flow paths
- Investigation of vapor phase transport through the vadose zone in Hawaiian rocks

Findings relevant to current project:

- Conventional model of groundwater hydrogeology in Hawaii (e.g. Ghyben-Herzberg model) is seriously incomplete
- At multiple scales – site specific to regional scale
- Groundwater storage and flow is controlled by multiple geologic features: dikes, sills, flow units, lava tubes, ash beds, weathering horizons, etc., that may be cross cutting or conformable with pre-existing/overlying topography
- Recent analysis of soil vapor data from 2013/2014 release suggests both rapid lateral and vertical liquid and vapor phase transport through the vadose zone of Red Hill Ridge

Concepts relevant to design of a tracer test in this region:

- All the above named controls on groundwater flow (as well as some others) are either recognized to be present, or have been asserted to be present, within the region
- Their scale and orientation are not well defined and are “difficult” to predict/infer where we have no data
- The chemical compositions of groundwater from the RH suite of monitoring wells suggest a much more complex flow regime than any model, to date, has been able to fully account for